PATENT ABSTRACTS OF JAPAN

(11)Publication number : 11-142739
(43)Date of publication of application : 28.05.1999

(51)Int.CI. G02B 15/20
G02B 13/18

(21)Application number : 09-319196
(22)Date of filing : 06.11.1997
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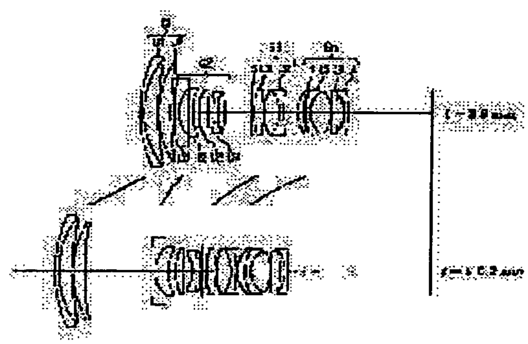
(54) ZOOM LENS

(57)Abstract:
PROBLEM TO BE SOLVED: To provide the small-diameter, small-sized high-performance zoom lens which has excellent cost performance and an about ×3.5 to 3.8 power variation ratio and is easily manufactured.
SOLUTION: Of the zoom lens which includes a 1st positive lens group G1, a 2nd negative lens group G2, and a lens group Gm which has at least one lens group and positive refracting power in order from the object side and varies the power by varying the air gap between the 1st and 2nd lens groups, the lens group Gm has a a positive meniscus lens element L1 which is convex to the object side, a cemented positive lens element L2 which is convex to the object side and formed by cementing a negative and a positive lens, and a negative meniscus lens element L4 which is convex to the image side in order from the object side, has a convex meniscus air lens which is convex to the object side between the positive meniscus lens element L1 and cemented positive lens element L2, and also has a meniscus air lens which is convex to the image side between the positive lens element L3 and negative lens element L4.



LEGAL STATUS

[Date of request for examination] 20.10.2004
[Date of sending the examiner's decision of rejection]
[Kind of final disposal of application other than the examiner's decision of rejection or application converted registration]
[Date of final disposal for application]
[Patent number]
[Date of registration]
[Number of appeal against examiner's decision of rejection]

[Date of requesting appeal against examiner's decision of rejection]
[Date of extinction of right]

CLAIMS

[Claim(s)]

[Claim 1] The 1st lens group G1 which has forward refractive power sequentially from a body side, and the 2nd lens group G2 which has negative refractive power, In the zoom lens which performs variable power by having at least one lens group and changing air spacing of said lens group G1 and said 2nd lens group G2 including the lens group Gm of forward refractive power The positive meniscus lens component L1 of which said lens group Gm turned the convex to the body side sequentially from the body side, The junction positive lens component L2 which turns a convex and is from junction of a negative lens and a positive lens on a body side, It has the positive lens component L3 and the negative meniscus lens component L4 which turned the convex to the image side. It has the air lens which is from the meniscus configuration where the convex was turned on a body side between said positive meniscus lens component L1 and said junction positive lens component L2. And the zoom lens characterized by having the air lens which consists of a meniscus configuration where the convex was turned at the image side between said positive lens components L3 and said negative lens components L4.

[Claim 2] It is 0<(Rb-Ra)/(Rb+Ra)<=l, when the radius of curvature of the field by the side of the image of said positive meniscus lens component L1 is set to Ra and the radius of curvature of the field by the side of the body of said junction positive lens component L2 is set to Rb. (1)
The zoom lens according to claim 1 characterized by satisfying ******.

[Claim 3] When the radius of curvature of the field by the side of the image of Rl and said positive meniscus lens component L1 is set to Ra for the radius of curvature of the field by the side of the body of said positive meniscus lens component L1, it is 0<(Ra-R1)/(Ra+R1) <=1. (2)
The zoom lens according to claim 1, 2, or 3 characterized by satisfying ******.

[Claim 4] It is -1 <=(Rd-Rc)/(Rd+Rc)<0 when the radius of curvature of the field by the side of the body of Rc and said negative lens component L4 is set to Rd for the radius of curvature of the field by the side of the image of said positive lens component L3. (3)
The zoom lens according to claim 1, 2, or 3 characterized by satisfying ******.

[Claim 5] When a refractive index [as opposed to d line of the positive lens by the side of the image in n concave and said junction positive lens component L2 for the refractive index to d line (lambda= 587.56nm) of the negative lens by the side of the body in said junction positive lens component L2] is made into n convex, it is n convex <n concave. (4)
Claims 1, 2, and 3 characterized by satisfying ******, or a zoom lens given in four.

[Claim 6] Distance on the optical axis to the field by the side of a body is most set to d12. said positive meniscus lens component L1 -- most -- the field by the side of an image to said junction positive lens component L2 -- Distance on the optical axis to the field by the side of a body is most set to d23. said junction positive lens component L2 -- most -- the field by the side of an image to said positive lens component L3 -- Most, said positive lens component L3 is 0.1<d12/d34<7, when [of the field by the side of an image to said negative lens component L4] distance on the optical axis to the field by the side of a body is most set to d34. (5)
0.01<d23/d34<5 (6)
Claims 1, 2, 3, and 4 characterized by satisfying ******, or a zoom lens given in five.

[Translation done.]

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention] This invention is excellent in cost performance with a small light weight, and relates to a zoom lens with a comparatively easy manufacture assembly, and an especially compact standard zoom lens.
[0002]
[Description of the Prior Art] In recent years, the case where a zoom ratio is carried while a miniaturization and low-cost-izing of the so-called 3 to 4 times as many standard zoom lens as this were enhanced and the camera body had been equipped by it has increased very much, including a wide angle. For this reason, it has image formation engine performance small, lightweight [a standard zoom lens], and sufficient, and the still cheaper thing has been indispensable conditions. It is necessary to constitute each lens group of a zoom lens from strong power to satisfy these conditions, and to carry out the thinning of each lens group as much as possible. In order to mitigate lens number of sheets for thinning, it is effective to introduce an aspheric lens. In recent years, the example which uses an aspheric lens for the 2nd group of 4 group zoom lens whose power arrangement which an aspheric lens can have, and can produce now, for example, is indicated by JP,8-248319,A is forward negative-positive-positive one and positive/negative negative-positive, the 4th group, etc. is increasing. [cheap] Moreover, this aspheric surface is possible also for using it for the back group of zoom lenses of five or more groups, such as forward negative-positive negative-positive one, etc., and can expect the effectiveness of the same thinning. Furthermore, the zoom lens indicated by JP,4-40689,B, JP,61-60418,B, JP,1-46044,B, JP,62-270910,A, JP,6-337354,A, etc. is in the example which tried a miniaturization and minor-diameter-izing of a standard zoom lens, without using the aspheric surface.
[0003]
[Problem(s) to be Solved by the Invention] However, in the forward negative-positive-positive 4 group zoom lens represented by the zoom lens indicated by JP,8-248319,A, there is a problem that processing of the aspheric lens in 4 groups is comparatively difficult, and an eccentric precision at the time of lens-barrel inclusion and air spacing precision are severe, and it is difficult to manufacture maintaining the design engine performance enough. Moreover, since the cost concerning assembly adjustment also increases, there is an inclination for the effectiveness in the cost side of mitigation of the lens number of sheets by adoption of an aspheric lens to be offset.
[0004] Moreover, the zoom lens indicated by JP,4-40689,B and JP,61-60418,B which tried a miniaturization and minor-diameter-izing of a standard zoom lens, JP,1-46044,B, JP,62-270910,A, JP,6-337354,A, etc., without using the aspheric surface is comparatively large-sized, and the about 3-time thing of a zoom ratio is in use. For this reason, even if a zoom ratio is large, it is large-sized, and there is also much configuration number of sheets and it is inadequate. [of optical-character ability]
[0005] the ** which this invention is made in view of the above-mentioned problem, and does not use the aspheric surface for a back lens group severe in precision — a minor diameter and

small and small lens configuration number of sheets — it is — cost performance — excelling — fewer variable power ratios of the difficulty at the time of manufacture — about 3.5 to 3.8 times — and it aims at offering a highly efficient zoom lens.

[0006]

[Means for Solving the Problem] In order to attain the above-mentioned purpose, the zoom lens of this invention The 1st lens group G1 which has a forward refraction mosquito sequentially from a body side, and the 2nd lens group G2 which has negative refractive power, By having at least one lens group and changing air spacing of said lens group G1 and said 2nd lens group G2 including the lens group Gm of forward refractive power, it sets on the zoom lens which performs variable power, and is [0007]. Said lens group Gm has the positive meniscus lens component L1 which turned the convex to the body side, the junction positive lens component L2 which turns a convex and is from junction of a negative lens and a positive lens on a body side, the positive lens component L3, and the negative meniscus lens component L4 which turned the convex to the image side sequentially from a body side, and is [0008]. It is characterized by having the air lens which consists of a meniscus configuration where have the air lens which is from the meniscus configuration where the convex was turned on a body side between said positive meniscus lens component L1 and said junction positive lens component L2, and the convex was turned to the image side between said positive lens components L3 and said negative lens components L4.

[0009]

[Embodiment of the Invention] The zoom lens of this invention is a lens which secured and improved the good engine performance, without taking the design approach which used the effectiveness of an aspheric lens for the lens configuration of the back group (a master group) of the convex precedence zoom lens which makes a forward negative-positive-positive type representation fundamentally extremely. It sets on the zoom lens of this invention especially. An important configuration The point of having the positive meniscus lens component L1 which turns a convex to a body side and has a strong meniscus configuration in said lens group Gm which hits the back group (master group) of a convex lens precedence mold zoom lens, It has the air lens which consists of a meniscus configuration where the convex was turned at the body side between said positive meniscus lens component L1 and said junction positive lens component L2. And it is the point of having the air lens which consists of a meniscus configuration where the convex was turned at the image side between said positive lens components L3 and said negative lens components L4. By this configuration, in each lens, high order aberration is generated and amendment of spherical aberration or comatic aberration is performed good as a result.

[0010] Moreover, said air lens has turned the concave surface toward the core of the lens group Gm, respectively, and good aberration amendment is attained by considering as a suitable configuration, without using the aspheric surface. Moreover, said junction positive lens component L2 is performing amendment of the PETTSU bar sum and axial overtone aberration.

[0011] As explained above, with the zoom lens of this invention, the lens configuration which gives [whether it can do and] all possible aberration amendment degrees of freedom for the back group (master group) of a convex precedence zoom lens as an independent objective lens system is adopted. Consequently, good aberration amendment is possible and the easy multi-group zoom lens of manufacturing can be attained.

[0012] Moreover, the zoom lens of this invention is the following conditional expression (1) and

0<(Rb-Ra)/(Rb+Ra)<=l. (1)

It is desirable that it is satisfied.

[0013] Here, Ra expresses the radius of curvature of the field by the side of the image of said positive meniscus lens component L1, and Rb expresses the radius of curvature of the field by the side of the body of said junction positive lens component L2, respectively.

[0014] Conditional expression (1) has specified the range where the configuration of the air lens of the meniscus configuration where the convex was turned to the body side which exists between the lens component L1 in the lens group Gm and said positive lens component L2 is suitable. With the zoom lens of this invention, unlike four groups of the zoom lens represented by

JP,8-248319,A, the lens group Gm which is also a master lens group is performing aberration amendment independently good comparatively, and the configuration of the aforementioned air lens serves as an important element as shown also in the example which carries out a postscript. When exceeding the upper limit of conditional expression (1), the configuration of the air lens (henceforth "the air lens by the side of the body in the lens group Gm") which consists of a meniscus configuration where the convex was turned to the body side between the lens component L1 in the lens group Gm and said positive lens component L2 will turn into a planoconvex configuration, and the angle of deviation of the air lens by the side of the body in the lens group Gm will change remarkably. Consequently, it becomes [suppressing change of the spherical aberration in good amendment and each focal distance of spherical aberration] difficult and is not desirable. Still more preferably, if the upper limit of conditional expression (1) is set to 0.6 or less and 0.4 or less, many aberration, such as spherical aberration, can be amended more to fitness. Moreover, if the upper limit of conditional expression (1) is set or less to 0.3, the effectiveness of this invention can be demonstrated to the maximum extent. On the contrary, when less than the lower limit of conditional expression (1), the configuration of the air lens by the side of the body in the lens group Gm turns into the configuration of the reverse sense where the convex configuration was turned to the image side. For this reason, it becomes [the angle of deviation of the air lens by the side of the body in the lens group Gm changes remarkably, and / as a result / suppressing change of the spherical aberration in good amendment and each focal distance of spherical aberration] difficult like the case where it exceeds a upper limit, and is not desirable.
[0015] Moreover, conditional-expression (2)$0<(Ra-R1)/(Ra+R1) <=1$ of the following [the zoom lens of this invention] (2)
It is desirable that it is satisfied.
[0016] Here, R1 expresses the radius of curvature of the field by the side of the body of said positive meniscus lens component L1, and Ra expresses the radius of curvature of the field by the side of the image of said positive meniscus lens component L1, respectively.
[0017] Conditional expression (2) has specified the suitable bending configuration of the lens component L1 of turning a convex to the body side in said lens group Gm, and having a meniscus configuration as a whole. Said lens component L1 may have the single lens or the cemented lens, and, in the case of a cemented lens, presupposes it that the configuration of the lens component L1 whole is specified. Said lens component L1 is mainly performing amendment of spherical aberration and axial overtone aberration. Especially, high order spherical aberration is generated and fluctuation of the spherical aberration in each focal distance is suppressed. Therefore, good aberration amendment is attained by setting the angle of deviation of each field of said lens component L1 to the flux of light which carries out incidence in parallel with an optical axis as a suitable value. When exceeding the upper limit of conditional expression (2), in order that the configuration of said lens component L1 may approach a planoconvex configuration, it changes in the direction in which the angle of deviation of the field by the side of an image decreases. In order that the aberration amendment effectiveness of the next air lens may also decrease, the optimal high order spherical aberration stops moreover, occurring. Consequently, it becomes difficult to suppress fluctuation of the spherical aberration in each focal distance. Still more preferably, if the upper limit of conditional expression (2) is set or less to 0.6, many aberration, such as spherical aberration, can be amended more to fitness. Moreover, if the upper limit of conditional expression (2) is set or less to 0.3, the effectiveness of this invention can be demonstrated to the maximum extent. On the contrary, when less than the lower limit of conditional expression (2), the configuration of said lens component L1 will turn into the configuration of the reverse sense where the convex configuration was turned to the image side. For this reason, the angle of deviation in said lens component L1 each side changes remarkably like the case where it exceeds a upper limit. For this reason, it becomes [suppressing change of the spherical aberration in good amendment and each focal distance of spherical aberration] difficult and is not desirable.
[0018] Moreover, conditional-expression (3)$-1 <=(Rd-Rc)/(Rd+Rc)<0$ of the following [the zoom lens of this invention] (3)

It is desirable that it is satisfied.
[0019] Here, Rc expresses the radius of curvature of the field by the side of the image of said positive lens component L3, and Rd expresses the radius of curvature of the field by the side of the body of said negative lens component L4, respectively.
[0020] Conditional expression (3) has specified the range where the configuration of the air lens which consists of a meniscus configuration where the convex was turned to the image side between the positive lens component L3 in said lens group Gm and said negative lens component L4 is suitable. Unlike four groups of the zoom lens represented with the zoom lens of this invention by JP,8-248319,A as shown also in the example which carries out a postscript, the lens group Gm which is also a master lens group needs to perform aberration amendment independently good comparatively, and the configuration of the aforementioned air lens is important. When exceeding the upper limit of conditional expression (3), the configuration of the air lens (henceforth "the air lens by the side of the image in the lens group Gm") which consists of a meniscus configuration where the convex was turned to the image side between the positive lens component L3 in the lens group Gm and said negative lens component L4 will turn into the configuration of the reverse sense where the convex configuration was turned to the body side. For this reason, the angle of deviation of an air lens changes remarkably, and amendment of ****** aberration including upper part comatic aberration and the chromatic aberration of magnification becomes difficult as a result. On the contrary, when less than the lower limit of conditional expression (3), the configuration of the air lens by the side of the image in the lens group Gm will turn into a planoconvex configuration. For this reason, the angle of deviation of an air lens changes remarkably, and amendment of ****** aberration including upper part comatic aberration and the chromatic aberration of magnification becomes difficult like the case where it exceeds an upper limit. Still more preferably, if the lower limit of conditional expression (3) is set to -0.8 or less and -0.7 or less, ****** aberration including upper part comatic aberration and the chromatic aberration of magnification can be amended more to fitness. Moreover, if the lower limit of conditional expression (3) is set or less to -0.6, the effectiveness of this invention can be demonstrated to the maximum extent.
[0021] Moreover, conditional-expression of the following [the zoom lens of this invention] (4) n convex <n concave (4)
It is desirable that it is satisfied.
[0022] Here, n concave expresses the refractive index [as opposed to / in n convex / d line of the positive lens by the side of the image in said junction positive lens component L2 for the refractive index to d line (lambda= 587.56nm) of the negative lens by the side of the body in said junction positive lens component L2], respectively.
[0023] Conditional expression (4) has specified the suitable refractive-index difference of the negative lens by the side of the body in said junction positive lens component L2, and the positive lens by the side of an image. When not filling conditional expression (4), it becomes impossible for the PETTSU bar sum to set it as a suitable value, and it becomes impossible to keep astigmatism and a curvature of field good as a result, and it is not desirable.
[0024] Moreover, conditional-expression (5) (6)0.1<d12/d34<7 of the following [the zoom lens of this invention] (5)
0.01<d23/d34<5 (6)
It is desirable that it is satisfied.
[0025] here -- d12 -- said positive meniscus lens component L1 -- most -- the field by the side of an image to said junction positive lens component L2 -- most the distance on the optical axis to the field by the side of a body d23 -- said junction positive lens component L2 -- most -- the field by the side of an image to said positive lens component L3 -- most -- the distance on the optical axis to the field by the side of a body -- d34 -- said positive lens component L3 -- most -- the field by the side of an image to said negative lens component L4 -- the distance on the optical axis to the field by the side of a body is expressed most, respectively.
[0026] Conditional expression (5) has specified the ratio with suitable thickness on the optical axis of the air lens between said lens components L1 and said positive lens components L2 and thickness of the air lens between the positive lens component L3 and said negative lens

component L4. When exceeding the upper limit of conditional expression (5), spacing of said lens component L1 and said positive lens component L2 will become remarkably large. For this reason, it becomes difficult for the aberration amendment effectiveness of an air lens to decrease remarkably, especially to suppress fluctuation of the spherical aberration in each focal distance. Still more preferably, if the upper limit of conditional expression (5) is set or less to five, many aberration, such as spherical aberration, can be amended more to fitness. Moreover, if the upper limit of conditional expression (5) is set or less to three, the effectiveness of this invention can be demonstrated to the maximum extent. On the contrary, when less than the lower limit of conditional expression (5), spacing of said lens component L1 and said positive lens component L2 becomes remarkably small. For this reason, it becomes difficult to suppress fluctuation of the spherical aberration in each focal distance as a result like the case where the aberration amendment effectiveness of an air lens decreases remarkably, and exceeds an upper limit. Moreover, if the lower limit of conditional expression (5) is set or more to 0.3, many aberration, such as spherical aberration, can be amended more to fitness. Moreover, if the lower limit of conditional expression (5) is set or more to 0.4, the effectiveness of this invention can be demonstrated to the maximum extent.

[0027] Conditional expression (6) has specified the ratio with suitable thickness on the optical axis of air spacing between said junction positive lens components L2 and said positive lens components L3 and thickness of the air lens between the positive lens component L3 and said negative lens component L4. When exceeding the upper limit of conditional expression (6), spacing of said junction positive lens component L2 and said positive lens component L3 will become remarkably large, or the thickness of the air lens between the positive lens component L3 and said negative lens component L4 will become remarkably small. In the case of the former, the total thickness of the lens group Gm is not contrary [remarkably large] to the request of miniaturization, and desirable. Moreover, in the case of the latter, it becomes [an air lens becomes remarkably thin / the aberration amendment effectiveness of an air lens decreases and / amendment of the aberration outside a shaft] difficult and is not desirable. Still more preferably, if the upper limit of conditional expression (6) is set to 3 or less and further 1 or less, the effectiveness of this invention can be demonstrated to the maximum extent. On the contrary, when less than the lower limit of conditional expression (6), spacing of said junction positive lens component L2 and said positive lens component L3 will become remarkably small, or the thickness of the air lens between said positive lens components L3 and negative lens components L4 will become remarkably large. Like the case where this exceeds an upper limit, the aberration amendment effectiveness of an air lens decreases and amendment of ****** aberration including upper part comatic aberration and the chromatic aberration of magnification becomes difficult as a result. Moreover, if the lower limit of conditional expression (6) is set to 0.02 or more and further 0.03 or more, the effectiveness of this invention can be demonstrated to the maximum extent.

[0028]

[Example] The zoom lens applied to the gestalt of operation of this invention based on an accompanying drawing below is explained.

[0029] (The 1st example) Drawing 1 is drawing showing the migration locus of each lens group to the tele edge concerning the 1st example of this invention from the lens configuration and wide angle edge of a zoom lens. The zoom lens concerning the 1st example consists of the 1st lens group G1 which has forward refractive power, a 2nd lens group G2 which has negative refractive power, 3rd lens group G3 which has forward refractive power, and forward [of the 4th lens group Gm] and four negative, forward, and forward lens groups which have forward refractive power sequentially from the body side.

[0030] The 1st lens group G1 consists of a junction positive lens L11 which consists of junction to the negative meniscus lens and positive meniscus lens which turned the convex to the body side, and a positive meniscus lens L12 which turned the convex to the body side from a body side. The 2nd lens group G2 has the aspheric surface in a body side from a body side. It consists of junction negative meniscus lenses L24 which changed by junction to the negative meniscus lens L21, the biconcave lens L22, the biconvex lens L23, biconcave lens, and biconvex lens which

consist of compound of resin and a glass member, and turned the concave surface to the body side. 3rd lens group G3 consists of body sides from aperture-diaphragm S, a biconvex lens L31, and the junction positive lens L32 that consists of junction to a biconvex lens and a biconcave lens. The 4th lens group Gm from a body side It consists of the positive meniscus lens L1 which turned the convex to the body side, a junction positive lens L2 which consists of junction to the negative meniscus lens and biconvex lens which turned the convex to the body side, a positive meniscus lens L3 which turned the concave surface to the body side, and a negative meniscus lens L4 which turned the concave surface to the body side.

[0031] Variable power performs all lens groups by moving independently so that air spacing between the 1st lens group G1 and the 2nd lens group G2 may be expanded toward a tele edge from a wide angle edge, air spacing between the 2nd lens group G2 and 3rd lens group G3 may contract and air spacing between 3rd lens group G3 and the 4th lens group Gm may contract. Moreover, a short-distance focus moves in the direction of a body, and performs the 2nd lens group G2.

[0032] The item value of the zoom lens concerning the 1st example is shown in following Table 1. In a table, the number of the lens side which counted the field number from the body side, a refractive index [as opposed to / r / as opposed to / in radius of curvature and d / a spacing / d line (lambda= 587.56nm) in nd], and nud are the Abbe numbers. Moreover, in a focal distance and FNO, the f number and 2omega of field angles are shown, and Bf shows [f] the back focus, respectively.

[0033] Moreover, when the aspheric surface sets to S (y) distance (the amount of sags) which met in the direction of an optical axis from the tangential plane of the top-most vertices of each aspheric surface in vertical height y from an optical axis, and setting criteria radius of curvature to R and setting k and the n-th aspheric surface multiplier to Cn for a constant of the cone, it shall be given by the following aspheric surface formulas.

[0034]

[Equation 1]

$$S(y) = (y^2/R) / [1 + (1 - \kappa \cdot y^2/R^2)^{1/2}] + C3 \cdot |y|^3 + C4 \cdot y^4 + C5 \cdot |y|^5 + C6 \cdot y^6 + C7 \cdot |y|^7 + C8 \cdot y^8 + C9 \cdot |y|^9 + C10 \cdot y^{10} + C12 \cdot y^{12} + C14 \cdot y^{14}$$

[0035] In the lens data of front Naka, * mark is given to the aspheric surface and paraxial radius of curvature is hung up over radius of curvature r. Moreover, in all the following examples, an item value, an aspheric surface type, etc. use the same thing as the 1st example.

[0036]

[Table 1]

f=29-102mmFNO=3.58-4.572omega=75.1-23.6 degree (lens data)

Field number r d nd nud1 64.59733 1.60000 1.860741 23.01 2 43.93468 7.00000 1.603001 65.42 3 133.25217 0.10000 1.000000 4 44.96142 6.00000 1.620409 60.14 5 138.36050 D5 1.000000*6 359.22497 0.05000 1.495210 56.34 7 80.00000 1.60000 1.840421 43.35 8 13.94783 5.00000 1.000000 9 -50.56575 1.00000 1.796681 45.37 10 40.83988 0.50000 1.000000 11 27.38145 4.00000 1.688930 31.08 12 -39.38317 1.60000 1.000000 13 -16.51500 1.10000 1.772789 49.45 14 336.30779 2.35000 1.804581 25.50 15 -35.86929 D15 1.000000 16 (aperture diaphragm) 1.250001.000000 17 96.46656 3.20000 1.612720 58.54 18 -50.68213 0.10000 1.000000 19 33.10808 6.00000 1.620409 60.14 20 -23.70721 1.50000 1.834000 37.35 21 138.45459 D21 1.000000 22 15.04790 3.20000 1.603001 65.42 23 17.07072 1.30000 1.000000 24 27.02352 1.85000 1.796681 45.37 25 11.88653 8.50000 1.516800 64.10 26 -39.19592 1.00000 1.000000 27 -92.62640 6.00000 1.487490 70.41 28 -19.29532 1.20000 1.000000 29 -14.89949 1.50000 1.796681 45.37 30 -34.25972 BF1.000000 (aspheric surface multiplier)

6th page kappa 400.000C3 - 0.24560x10-4C4 2.81770x10-5C5 0.65534x10-6C6 - 1.18080x10-7C7 - 0.89550x10-9C8 5.09810x10-10C9 0.0C10 -1.0874x10-12C12 0.31692x10-14C14 0.0F

29.00000 50.00000 102.00000 D0 0.0000 0.00000.0000 D5 1.82043 12.60993 29.69067 D15 11.73242 5.99633 0.87257 D21 5.793092.61711 0.82545 BF 37.9428951.71070 63.53376beta -0.03333 -0.03333 -0.03333 D0 818.4666 1411.8082 2817.2270 D5 1.31685 12.14048 28.95724 D15 12.23600 6.46578 1.60600 D21 5.79309 2.61711 0.82545 BF37.94948 51.71726 63.54029beta - 0.06945 -0.11481 -0.19148 - 0.50000 D0 367.3112 351.6660 329.6774 44.8350 D5 0.78191 11.03629 26.00578 21.58877 D15 12.77094 7.56997 4.55746 8.97447 D21 5.79309 2.61711 0.82545 0.82545 BF 37.97169 51.78941 63.75280 65.09963 (value corresponding to conditions) (1) (Rb-Ra)/(Rb+Ra) 0.2257 (2) and (Ra-R1) /(Ra+R1) 0.06298(3) (Rd-Rc)/(Rd+Rc) -0.1286 (5) d12/d34 1.083 (6) d23/d34 0.8333 [0037] Drawing 2 thru/or drawing 4 are drawings showing many aberration of the zoom lens concerning the 1st example. As for FNO, the f number and Y show [image quantity, and d and g] among drawing that it is the aberration curve of d line and g line, respectively. Moreover, in the astigmatism Fig., a continuous line shows the sagittal image surface and the dotted line shows the meridional image surface. Hereafter, in the aberration Fig. of all examples, the same sign as the 1st example is used.

[0038] Drawing 2 is an aberration Fig. at the time of an infinite distance focus in a wide angle edge. It turns out that it covered enough to the large field angle, and aberration amendment has accomplished good. Drawing 3 is an aberration Fig. at the time of an infinite distance focus with a middle focal distance. It turns out like a wide angle edge that aberration amendment has accomplished good. Drawing 4 is an aberration Fig. at the time of the infinite distance focus of a tele edge. It turns out like a wide angle edge that aberration **** has accomplished good.

[0039] (The 2nd example) Drawing 5 is drawing showing the migration locus of each lens group to the tele edge concerning the 2nd example of this invention from the lens configuration and wide angle edge of a zoom lens. The zoom lens concerning the 2nd example consists of the 1st lens group G1 which has forward refractive power, a 2nd lens group G2 which has negative refractive power, 3rd lens group G3 which has forward refractive power, and forward [of the 4th lens group Gm] and four negative, forward, and forward groups which have forward refractive power sequentially from the body side.

[0040] The junction positive lens L11 with which the 1st lens group G1 consists of a body side from junction to the negative meniscus lens and positive meniscus lens which turned the convex to the body side, It consists of positive meniscus lenses L12 which turned the convex to the body side. The 2nd lens group G2 from a body side It consists of junction negative meniscus lenses L24 which changed by junction to the negative meniscus lens L21 which has the aspheric surface, the negative meniscus lens L22 which turned the convex to the body side, a biconvex lens L23, a biconcave lens, and a biconvex lens, and turned the concave surface to the body side at the body side. 3rd lens group G3 consists of body sides from aperture-diaphragm S, a biconvex lens L31, and the junction positive lens L32 that consists of junction to a biconvex lens and a biconcave lens. The 4th lens group Gm consists of negative meniscus lenses L4 which turned the concave surface to the positive meniscus lens [which turned the convex to the body side] L1, junction positive lens [which consists of junction to the negative meniscus lens and biconvex lens which turned the convex to the body side] L2, biconvex lens L3, and body side from the body side. Variable power performs all lens groups by moving independently so that air spacing between the 1st lens group G1 and the 2nd lens group G2 may be expanded toward a tele edge from a wide angle edge, air spacing between the 2nd lens group G2 and 3rd lens group G3 may contract and air spacing between 3rd lens group G3 and the 4th lens group Gm may contract. Moreover, a short-distance focus moves in the direction of a body, and performs the 2nd lens group G2.

[0041] The item value of the zoom lens concerning the 2nd example is hung up over Table 2.

[0042]

[Table 2]

f=29-102mmFNO=3.6-4.572omega=75.9-23.7 degree (lens data)

Field number r d nd nud1 70.0252 1.60000 1.860741 23.012 44.6811 6.50000 1.651599 58.503 131.7460 0.10000 1.0000004 47.4730 5.5000 1.696800 55.605 136.3218 D5 1.000000*6 683.5968 1.6000 1.840421 43.357 16.8087 4.7000 1.0000008 482.9798 1.3000 1.796681 45.379 24.8354 3.0000 1.00000010 27.0282 4.0000 1.74950135.1911-300.2163 3.5000 1.00000012 -22.7363

1.2000 1.748099 52.3013 48.8582 3.0000 1.730378 25.4814 -53.8253 D14 1.00000015 (aperture diaphragm) 1.25000 1.0000001642.7427 4.50000 1.61272058.5417 -42.0877 0.10000 1.00000018 31.6326 6.50000 1.487490 70.4119 -20.3268 2.00000 1.796310 40.9020 80.6456 D20 1.00000021 16.6185 3.00000 1.516800 64.1022 22.3030 1.1000 1.00000023 36.1986 1.85001.796681 45.3724 13.1109 9.0000 1.516800 64.1025 -22.0295 0.1000 1.00000026 133.9818 3.6500 1.65159958.5027-60.2406 2.40001.00000028 -17.9678 1.5000 1.840421 43.3529 -85.7938 BF 1.000000 (aspheric surface multiplier)
6th page kappa 999.9990C3 - 0.64104x10-5C4 1.20800x10-5C5 - 0.90759x10-7C6 - 6.81290x10-9C7 0.0C8 - 3.10660x10-11C9 0.0C10 - 3.94870x10-14C12 0.12689x10-14C14 - 0.31162x10-17F 29.00000 50.00000 102.00000 D0 0.0000 0.0000 0.0000 D5 1.84796 12.57009 29.69641 D14 11.76638 5.99661 0.89832 D20 5.80368 2.92811 0.89823 BF 37.99779 51.89637 63.65702beta-0.03333 - 0.03333 -0.03333D0 818.6155 1412.2489 2817.7456 D5 1.3443812.10220 28.96449 D14 12.26996 6.46450 1.63024 D20 5.80368 2.92811 0.89823 BF 38.00437 51.90292 63.66355beta - 0.07025 -0.11625 - 0.19346 D0 362.7343 346.7589 325.0000 D5 0.79771 10.98254 25.98488 D14 12.81663 7.58417 4.60985 D20 5.80368 2.92811 0.89823 BF 38.02724 51.97705 63.88065 (value corresponding to conditions)
(1) (Rb-Ra)/(Rb+Ra) 0.2375 (2) and (Ra-R1) /(Ra+R1) 0.1460(3) (Rd-Rc)/(Rd+Rc) -0.5405 (5) d12/d34 0.4583 (6) d23/d34 0.04177 [0043] Drawing 6 thru/or drawing 8 are drawings showing many aberration of the zoom lens concerning the 2nd example. Drawing 6 is an aberration Fig. at the time of an infinite distance focus in a wide angle edge. It turns out that it covered enough to the large field angle, and aberration **** has accomplished good. Drawing 7 is an aberration Fig. at the time of an infinite distance focus with a middle focal distance. It turns out like a wide angle edge that aberration amendment has accomplished good. Drawing 8 R> 8 is an aberration Fig. at the time of the infinite distance focus of a tele edge. Aberration amendment has accomplished good like the wide angle edge.
[0044] (The 3rd example) Drawing 9 is drawing showing the migration locus of each lens group to the tele edge concerning the 3rd example of this invention from the lens configuration and wide angle edge of a zoom lens. The zoom lens concerning the 3rd example consists of the 1st lens group G1 which has forward refractive power, a 2nd lens group G2 which has negative refractive power, 3rd lens group G3 which has forward refractive power, and forward [of the 4th lens group Gm] and four negative, forward, and forward groups which have forward refractive power sequentially from the body side. The 1st lens group G1 consists of a junction positive lens L11 which consists of junction to the negative meniscus lens and positive meniscus lens which turned the convex to the body side, and a positive meniscus lens L12 which turned the convex to the body side from a body side. The 2nd lens group G2 consists of junction negative meniscus lenses L24 which changed by junction to the negative meniscus lens L21, the biconcave lens L22, the biconvex lens L23, biconcave lens, and biconvex lens which have the aspheric surface, and turned the concave surface to the body side from the body side at the body side. 3rd lens group G3 consists of body sides from aperture-diaphragm S, a biconvex lens L31, a biconvex lens L32, and the negative meniscus lens L33 that turned the concave surface to the body side. The 4th lens group Gm from a body side It consists of the positive meniscus lens L1 which turned the convex to the body side, a junction positive lens L2 which consists of junction to the negative meniscus lens and biconvex lens which turned the convex to the body side, a positive meniscus lens L3 which turned the concave surface to the body side, and a negative meniscus lens L4 which turned the concave surface to the body side. Variable power performs all lens groups by moving independently so that air spacing between the 1st lens group G1 and the 2nd lens group G2 may be expanded toward a tele edge from a wide angle edge, air spacing between the 2nd lens group G2 and 3rd lens group G3 may contract and air spacing between 3rd lens group G3 and the 4th lens group Gm may contract. Moreover, a short-distance focus moves in the direction of a body, and performs the 2nd lens group G2.
[0045] The item value of the zoom lens concerning the 3rd example is hung up over following Table 3.
[0046]
[Table 3]

f=29-102mmFNO=3.59-4.582omega=76.0-23.6 degree (lens data)
Field number r d nd nud1 61.6837 1.60000 1.860741 23.012 42.6724 6.8000 1.603001 65.423 117.6461 0.10000 1.0000004 46.9253 6.00000 1.640000 160.035 153.4126 D5 1.000000*6 694.9919 1.6000 1.840421 43.357 14.17474.5000 1.0000008 -91.3789 1.3000 1.796681 45.379 42.2384 0.1000 1.00000010 24.2192 4.5000 1.688930 31.0811 -46.7480 1.5000 1.00000012 - 16.7776 1.2000 1.772789 49.4513 125.0596 2.5000 1.730378 25.4814 -38.9897 D14 1.00000015 (aperture diaphragm) 1.2500 1.00000016 228.7356 3.7000 1.603001 65.4217 -48.3863 0.1000 1.00000018 34.5517 7.5032 1.60300165.4219 -28.5730 0.4000 1.00000020 -26.1399 2.0000 1.834000 37.3521-2845.3881 D21 1.00000022 15.5623 4.00001.516800 64.1023 19.6245 1.2000 1.00000024 28.8033 1.8500 1.796681 45.3725 11.7158 9.0000 1.516800 64.1026 -24.8963 0.1000 1.00000027-128.2692 3.00001.516800 64.1028-55.15302.5781 1.00000029-16.1444 1.5000 1.840421 43.3530 -29.6735 BF 1.000000 (aspheric surface multiplier)
6th page kappa 1431.8066C3 - 0.64097x10-5C4 1.91406x10-5C5 0.45506x10-7C6 - 2.18312x10-8C7 - 0.29054x10-9C8 4.09028x10-11C9 0.0C10 2.04008x10-13C12 0.35940x10-15C14 0.0F 29.00000 50.00000 102.00000 D0 0.00000.0000 0.0000 D5 1.83307 12.59655 29.68152 D14 11.76164 6.017880.89358 D21 5.80745 2.67012 0.90200 BF38.03070 51.83498 63.68994beta-0.03333 - 0.03333-0.03333 D0 818.66091412.1145 2817.7910 D5 1.3294912.12771 28.94960 D14 12.26522 6.48673 1.62550 D21 5.80745 2.67012 0.90200 BF 38.03724 51.841663.69642beta - 0.06969 - 0.11524 -0.19218 D0 366.0620 350.3753 328.3277 D5 0.79099 11.01925 25.99136 D14 12.803727.59519 4.58374 D215.80745 2.67012 0.90200 BF 38.05945 51.91362 63.90880 (value corresponding to conditions)
(1) (Rb-Ra)/(Rb+Ra) 0.1896 (2) and (Ra-R1) /(Ra+R1) 0.1154(3) (Rd-Rc)/(Rd+Rc) -0.5471 (5) d12/d34 0.4655 (6) d23/d34 0.03879 [0047] Drawing 10 thru/or drawing 12 are drawings showing many aberration of the zoom lens concerning the 3rd example. Drawing 10 is an aberration Fig. at the time of an infinite distance focus in a wide angle edge. It turns out that it covered enough to the large field angle, and aberration **** has accomplished good. Drawing 1111 is an aberration Fig. at the time of an infinite distance focus with a middle focal distance. It turns out like a wide angle edge that aberration amendment has accomplished good. Drawing 12 is an aberration Fig. at the time of the infinite distance focus of a tele edge. Aberration amendment has accomplished good like the wide angle edge.

[Translation done.]

DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1] It is drawing showing the lens configuration and migration locus of the zoom lens concerning the 1st example of this invention.
[Drawing 2] It is drawing showing many aberration at the time of an infinite distance focus in the wide angle edge of the zoom lens concerning the 1st example of this invention.
[Drawing 3] It is drawing showing many aberration at the time of an infinite distance focus with the middle focal distance of the zoom lens concerning the 1st example of this invention.
[Drawing 4] It is drawing showing many aberration at the time of the infinite distance focus by the tele edge of the zoom lens concerning the 1st example of this invention.
[Drawing 5] It is drawing showing the lens configuration and migration locus of the zoom lens concerning the 2nd example of this invention.
[Drawing 6] It is drawing showing many aberration at the time of an infinite distance focus in the wide angle edge of the zoom lens concerning the 2nd example of this invention.
[Drawing 7] It is drawing showing many aberration at the time of an infinite distance focus with the middle focal distance of the zoom lens concerning the 2nd example of this invention.
[Drawing 8] It is drawing showing many aberration at the time of the infinite distance focus by the tele edge of the zoom lens concerning the 2nd example of this invention.
[Drawing 9] It is drawing showing the lens configuration and migration locus of the zoom lens concerning the 3rd example of this invention.
[Drawing 10] It is drawing showing many aberration at the time of an infinite distance focus in the wide angle edge of the zoom lens concerning the 3rd example of this invention.
[Drawing 11] It is drawing showing many aberration at the time of an infinite distance focus with the middle focal distance of the zoom lens concerning the 3rd example of this invention.
[Drawing 12] It is drawing showing many aberration at the time of the infinite distance focus by the tele edge of the zoom lens concerning the 3rd example of this invention.
[Description of Notations]
Gl The 1st lens group
G2 The 2nd lens group
G3 The 3rd lens group
Gm The 4th lens group (master lens group)
S Aperture diaphragm
A Fixed diaphragm

[Translation done.]

* NOTICES *

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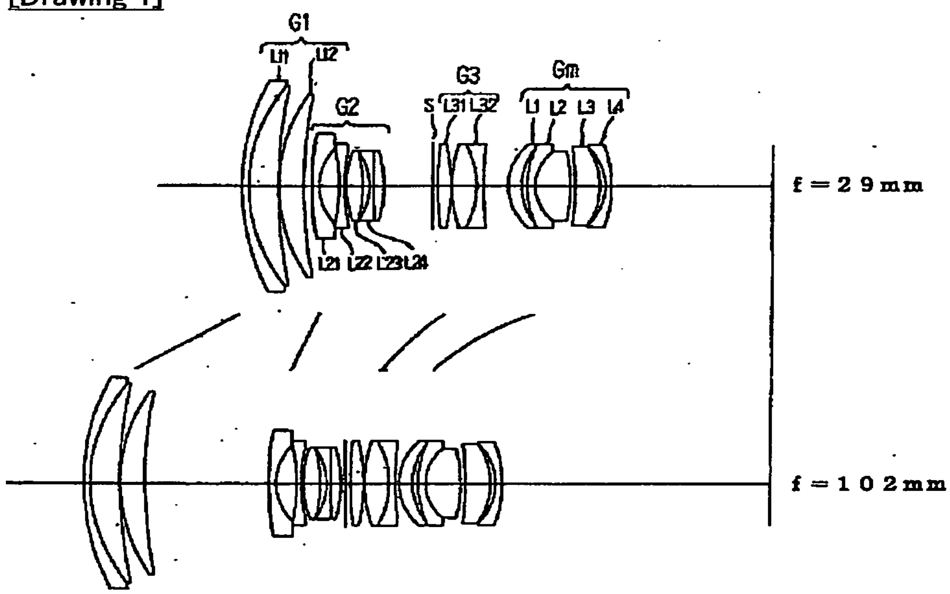
damages caused by the use of this translation.

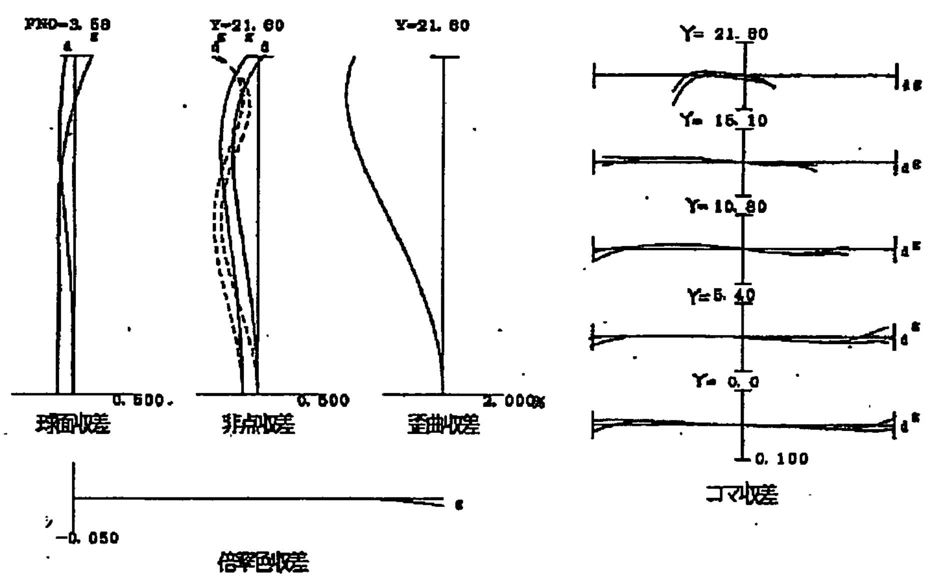
1.This document has been translated by computer. So the translation may not reflect the original precisely.
2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

DRAWINGS

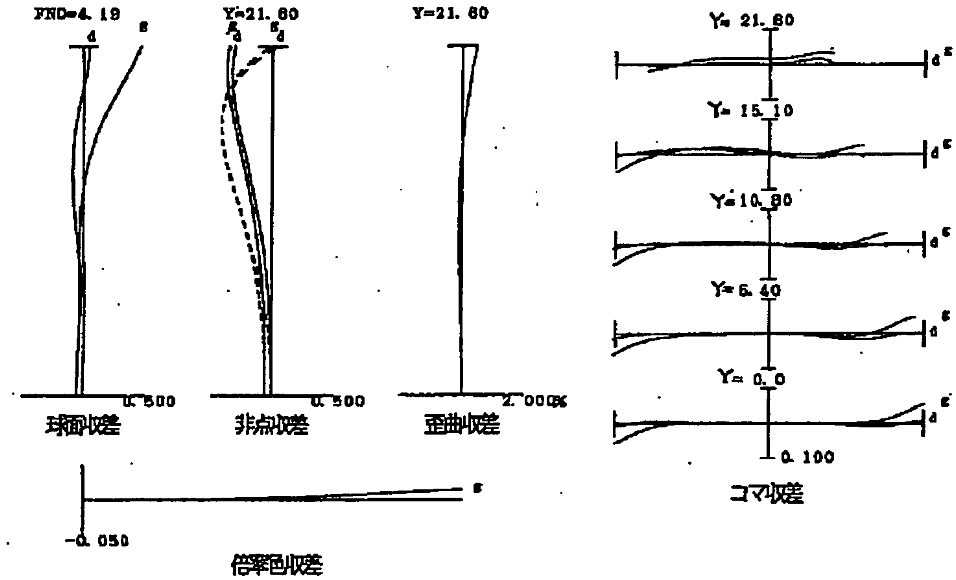
[Drawing 1]



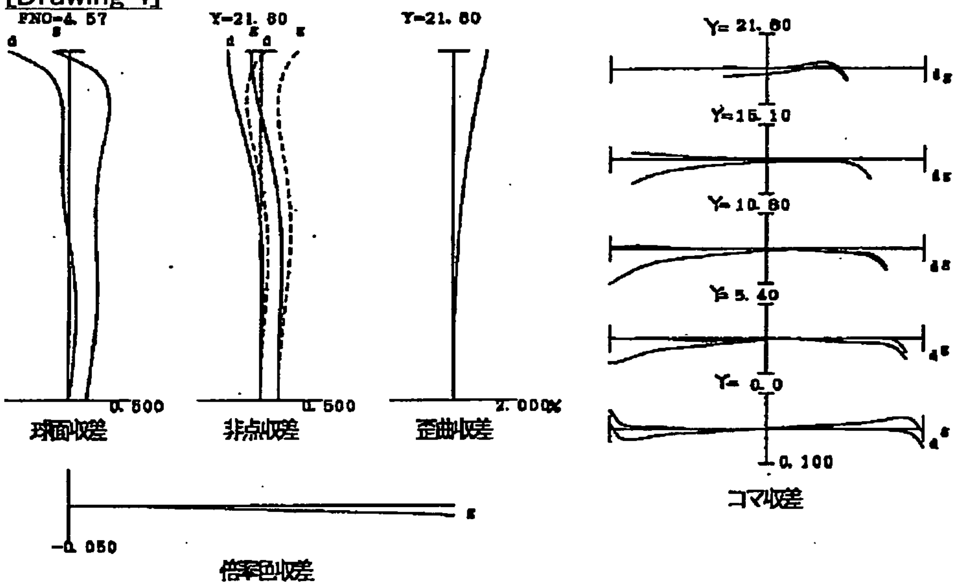
[Drawing 2]



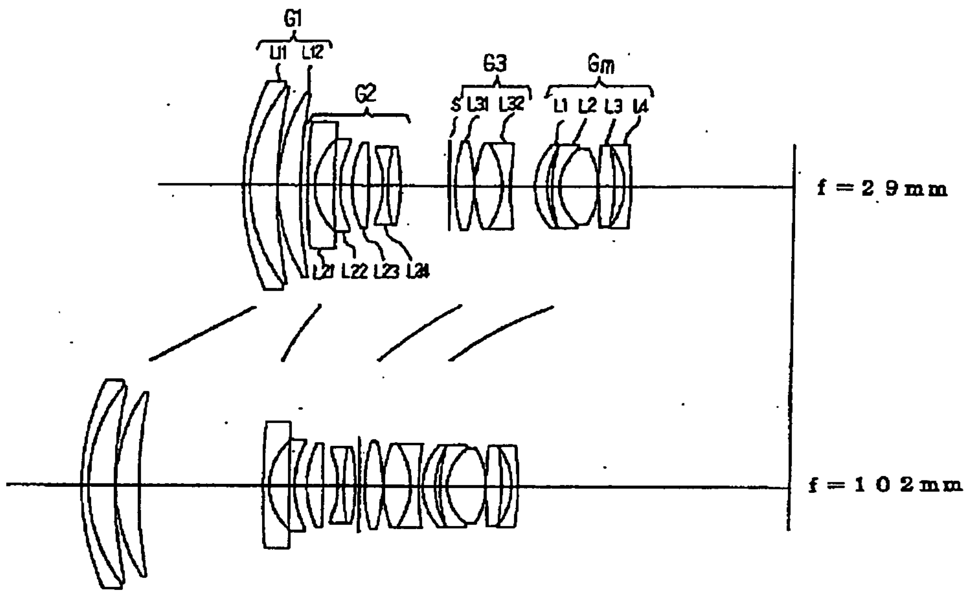
[Drawing 3]



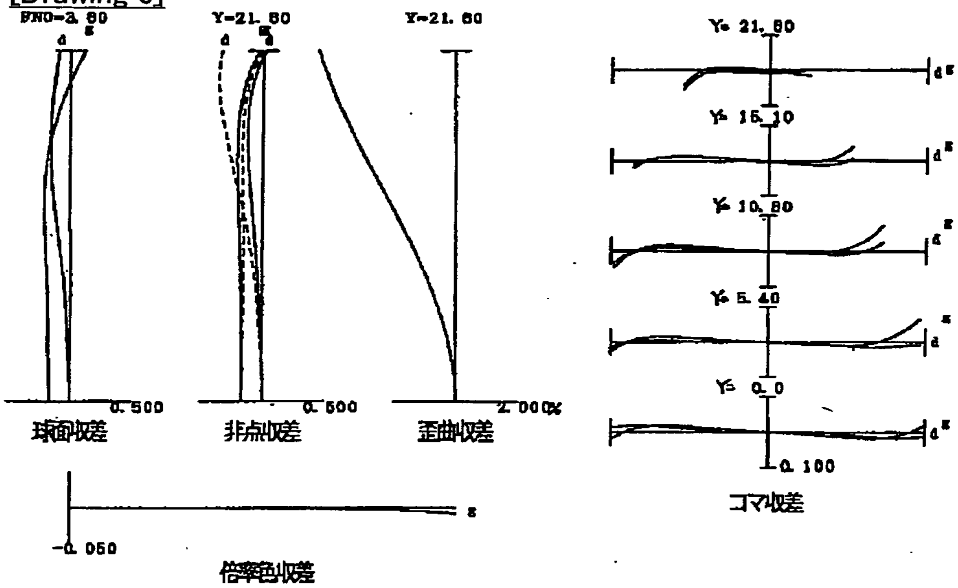
[Drawing 4]



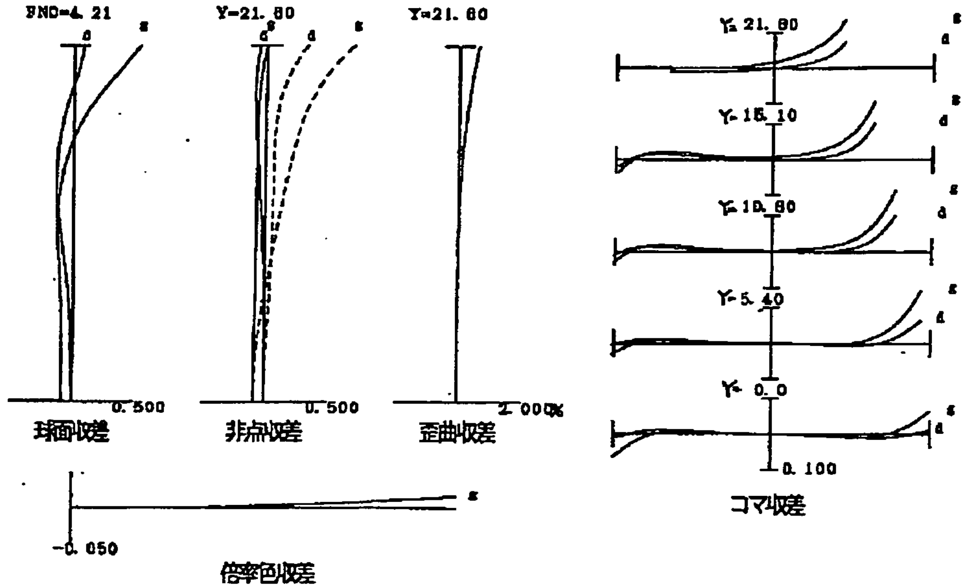
[Drawing 5]



[Drawing 6]



[Drawing 7]



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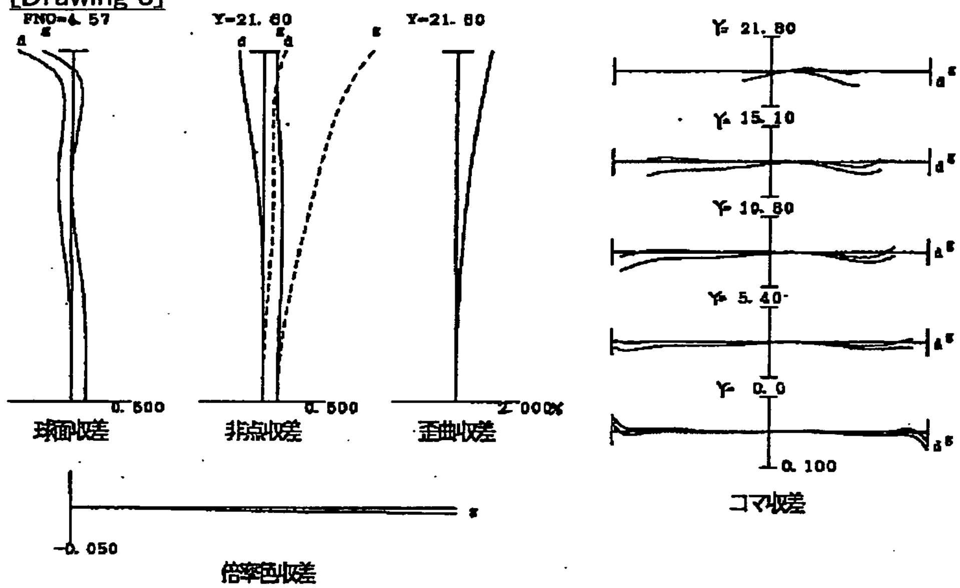
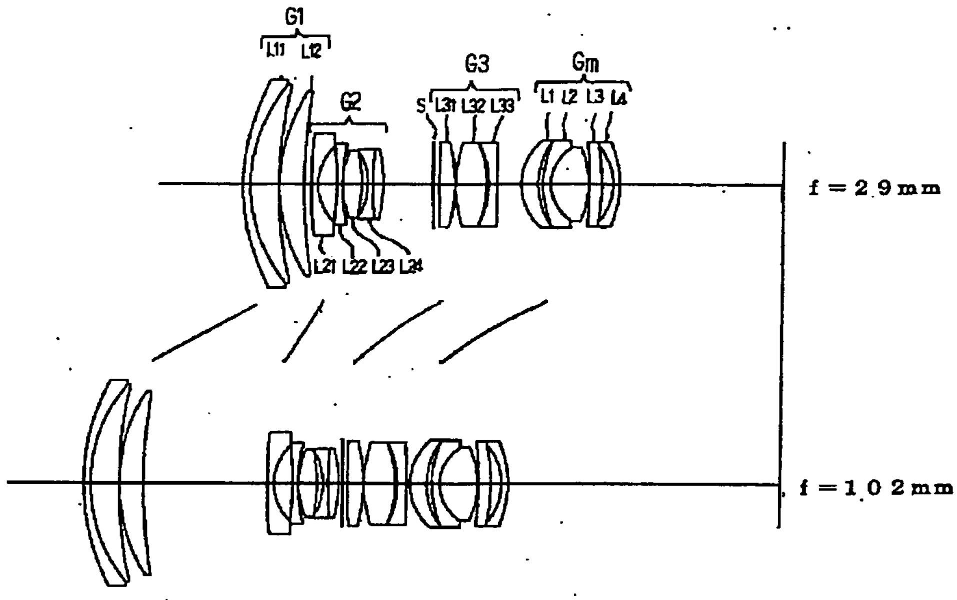
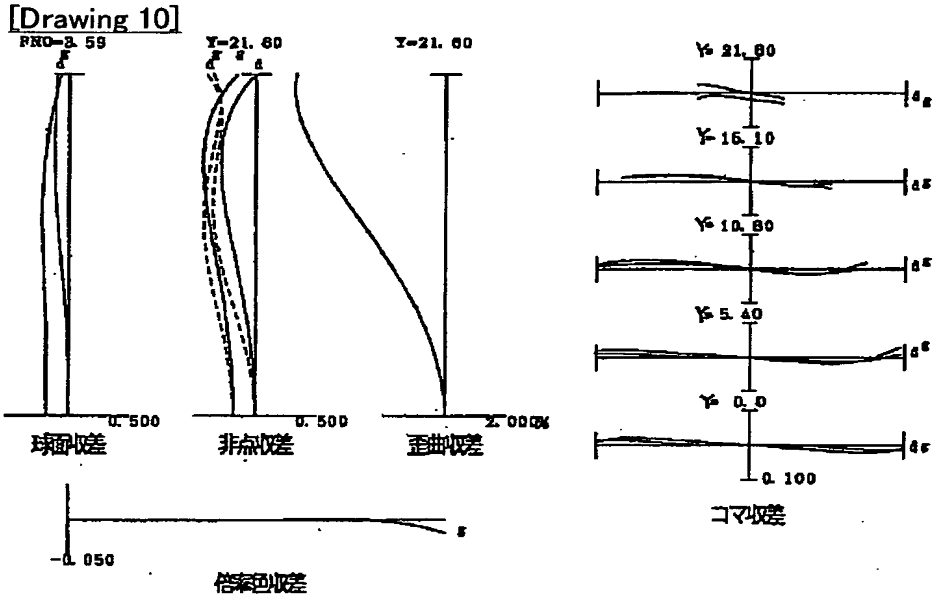


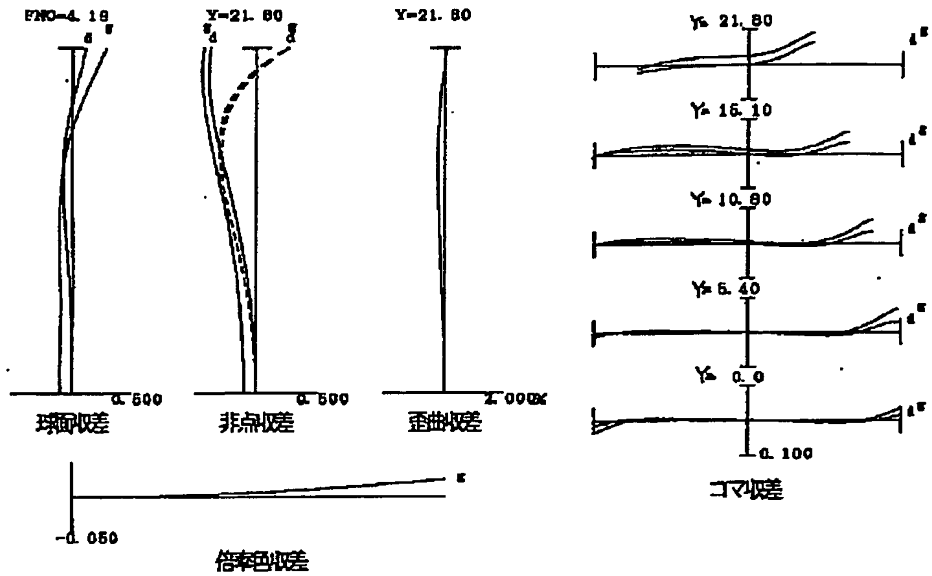
[Drawing 9]



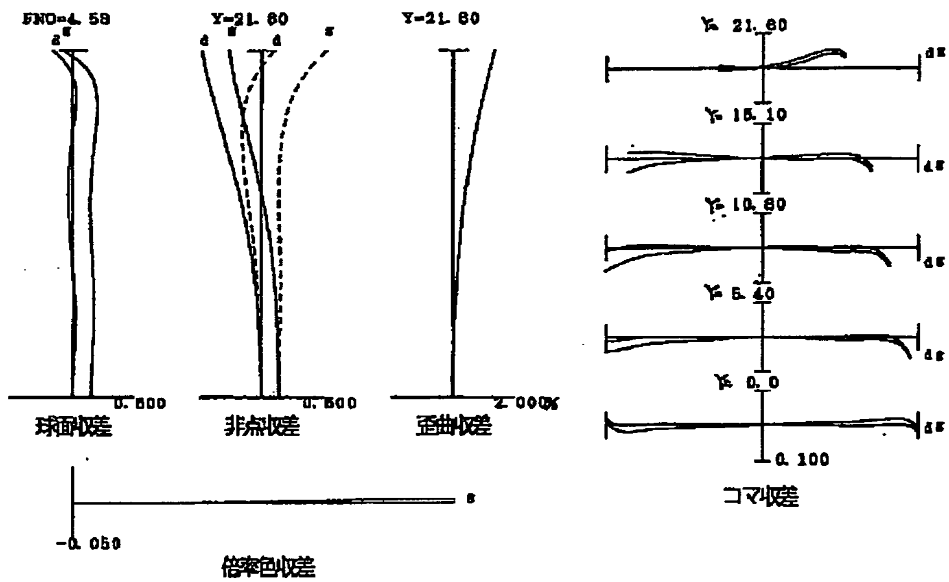
[Drawing 10]



[Drawing 11]



[Drawing 12]



[Translation done.]